

EPIC - 4000

Visual Electrodiagnostic Testing System

SERVICE MANUAL

Version 1.0

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Precautions

- All servicing of this equipment is to be performed by LKC Technologies, Inc. or by a service center approved by LKC Technologies, Inc.
- Do not open any access panel of the EPIC-4000 Ganzfeld for a minimum of 15 minutes after removing AC power from the system. Internal capacitors maintain a hazardous charge for this period.
- The EPIC-4000 testing system is an FDA Class II medical device that incorporates an IBM-compatible personal computer. To ensure patient safety, the entire EPIC-4000 system, including the personal computer and all of its peripherals are powered from an isolation transformer through the power receptacles on the Isolation Transformer Unit. All devices connected to the computer must be powered from these isolated power receptacles. Failure to observe this precaution may endanger patient safety and will void your warranty.

LKC Technologies, Inc. will not service a system whose computer is connected to external devices, nor will it give permission for others to service such a system.

Examples of improper connections include connecting the EPIC-4000 computer (whether supplied by LKC or by another party) to any form of local area network (LAN), to a laser printer, or to any other device that is plugged into a wall outlet or that is connected to another device that is plugged into a wall outlet (such as a printer sharing unit connected to another computer). If you have specific questions on this matter, please contact LKC Technologies, Inc. for advice.

EPIC-4000 testing system should only be serviced by qualified personnel.

WARRANTY

LKC Technologies, Inc. unconditionally warrants this instrument to be free from defects in materials and workmanship, provided there is no evidence of abuse or attempted repairs without authorization from LKC Technologies, Inc. This Warranty is binding for one year from date of initial delivery and is limited to: servicing and/or replacing any instrument, or part thereof, returned to the factory for that purpose with transportation charges prepaid and which are found to be defective. This Warranty is made expressly in lieu of all other liabilities and obligations on the part of LKC Technologies, Inc.

DAMAGE UPON ARRIVAL. Each instrument leaves our plant, after rigorous tests, in perfect operating condition. The instrument may receive rough handling and damage in transit. The shipment is insured against such damage. The Buyer must report, in writing, immediately any concealed or apparent damage to the last carrier. Report any damage also to us, and issue an order for replacement or repair.

DEFECTS OCCURRING WITHIN WARRANTY PERIOD. Parts of units may develop defects which no amount of initial testing will reveal. The price of our instruments makes provision for such service, but it does not:

1. Provide for transportation charges to our factory for service,
2. Provide for services not performed or authorized by us,
3. Provide for the cost of repairing instruments that have obviously been abused or subjected to unusual environments for which they have not been designed.

We will be happy at any time to discuss by phone, letter, FAX, or e-mail suspected defects or aspects of instrument operation that may be unclear. We advise you to inform us by phone, letter FAX, or e-mail of the nature of the defect before returning an instrument for repair. Many times a simple suggestion will solve the problem without returning an instrument to the factory. If we are unable to suggest something that solves the problem, we will advise you as to what parts of the equipment should be returned to the factory for service.

DEFECTS OCCURRING AFTER WARRANTY PERIOD. Charges for repairs after the warranty period will be based upon actual hours spent on the repair at the then prevailing rate, plus cost of parts required and transportation charges, or you may elect to purchase an extended warranty.

We will be happy to discuss by phone, letter, Fax, or e-mail any problem you may be experiencing.

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SOFTWARE LICENSE

The EMWin (and/or the optional Multi-Focal ERG, Sweep VEP) software is copyrighted product of LKC Technologies, Inc. and is included with the EPIC-4000 system under the following license agreement:

The software may be used in conjunction with the EPIC-4000 testing system only. The purchaser of the EPIC-4000 may make copies of the software for convenience of use, provided the LKC copyright notice is preserved with each copy. This license specifically prohibits the use of this software in a system that does not include an LKC EPIC-4000 Interface Unit. The software may be used by the purchaser of the EPIC-4000, however to produce reports of EPIC-4000 data using a stand-alone computer system.

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1.0 Introduction

The LKC EPIC-4000 Visual Electrodiagnostic Testing System is an ophthalmic evoked potential system. Its function is to elicit electrical responses from the retina and visual pathways for diagnostic purposes.

The EPIC-4000 is designed for the electroretinogram (ERG), electro-oculogram (EOG), visual evoked potential (VEP), sweep VEP and multi-focal ERG tests. These tests are useful in the diagnosis of a wide range of visual disorders.

This manual describes the interconnection of equipment, calibration, tests, theory of circuit operation and troubleshooting guide, which lists the most commonly encountered problems. For specific information on the above tests, please see the EPIC-4000 User's Manual.

1.1 Safety

The equipment has been tested in accordance with AAMI safe current limit standards and meets all requirements for Non-isolated patient connections.

WARNING

The EPIC-4000 system is a FDA Class II medical device that incorporates an Intel®-based personal computer. To ensure patient safety, all modules of the EPIC-4000, including the Interface, Ganzfeld/Mini-Ganzfeld and Pattern Stimulators, the personal computer and all of its peripherals are powered from an isolation transformer. No external devices may be connected to the EPIC-4000 without precautions to isolate them from the power mains.

Therefore, the EPIC-4000 computer must not be connected to any form of a local area network (LAN), to a laser printer, or any other device plugged into a wall outlet (such as a printer sharing unit connected to another computer). If you have specific questions on this matter, please contact LKC Technologies, Inc. for advice. Failure to observe this precaution may endanger patient safety and will void your warranty.

The Isolation Transformer used in the EPIC-4000 system is a multi-voltage unit. Both the input and output voltages are set up properly in LKC before shipping, to match the primary power voltage of the country where the end user locates. Change of the voltage setting(s) may cause damage of the equipments.

1.2 Use

This equipment is offered for sale only to qualified health professionals. The improper use of this equipment may be injurious to the patient.

2.0 Functional Description

In this section, the function of each equipment group is explained and a block diagram is discussed which shows equipment interrelationships.

2.1 Computer and Associated Devices

The computer is either a desktop or a notebook PC with a minimum of 2 GHz CPU speed, at least 256 MB of random access memory (RAM), a rewriteable CD drive, a 1.44 MB floppy disk drive and at least a 30 GB hard disk drive. The computer provides the control of all test and analysis operations.

There are two additional hardware components in the computer provided by LKC:

- ◆ PCI-bus compatible data acquisition board PCI-DAS1200JR for desktop version EPIC-4000 or data acquisition card PCM-DAS16/330 for laptop version. This part sends command signals to the Interface Unit to control the amplifier and filter settings. It also receives signals from the amplifier channels and converts them to digital data for processing by the computer and display on the monitor.
- ◆ AGP video board. This board sends video signals to the pattern monitor stimulator. In the laptop version, this board is built in the laptop computer and is not detachable.

2.2 System Interface Unit

The 2-channel Interface Unit contains three printed circuit boards, which are:

- Patient Amplifier¹ (1)
- Filter/Attenuator (1)
- Back Plane (1)

The Filter Board contains high pass and low pass filters that are set under computer control. The gain and filter settings for channels 1 and 2 are always equal.

¹ The patient amplifier board contains a DC-to-DC converter that supplies isolated power to the two patient amplifiers.

**Filter settings provided by the
Filter / Attenuator Board**

High Pass (Hz)	Low Pass (Hz)
0.05	30
0.3	70
1.0	100
5.0	300
10	500
30	1500
75	3000

The Filter Board also includes attenuators that are controlled by computer commands to set the gain for the amplifier channels. The gain options provided are shown below:

**Gain Settings Provided by
Filter / Attenuator Board**

Gain Setting (μV)	System Gain
± 2500	2,000
± 1250	4,000
± 500	10,000
± 250	20,000
± 125	40,000
± 50	100,000
± 25	200,000
± 12.5	400,000

The Back Plane Board provides the following:

- ± 12 V and +5 V regulated power for Amplifier and Filter boards
- Decoding of the computer commands
- Interconnections for the patient input, amplifier, filter/attenuator and analog/digital outputs to the computer
- Isolated TTL Trigger Input and Trigger Output circuits

2.3 Pattern Monitor Stimulator

The pattern stimulator consists of either a flat screen CRT color VGA monitor for Pattern VEP / Pattern ERG / Sweep VEP, or a high-brightness monochrome monitor if optional Multi-Focal ERG is added to the system, controlled by the AGP video card installed in the computer. Commands sent by the computer to the video card produce changes in the display on the pattern stimulator screen. The brightness and contrast of the screen can be adjusted under computer control.

The stimuli have three pattern formats: checker boards, gratings and sinusoidal. Grating and sinusoidal pattern stimuli can be presented vertically or horizontally. Pattern flickering rate can be set at .5, 1, 2, 5, 10, 15, 20, 25 or 30 Hz. All three pattern formats provide red, green, blue, white and black colors, except the monochrome monitor for Multi-Focal ERG testing, which is black and white only. In addition, pattern size can be set 25% through 100% of screen size and pattern contrast can be adjusted from 1% to 100%. The minimum arc is set by the width (or height) of stimulation objects and the distance between the patient and screen. See Software Manual for detail.

2.4 SG-2002 Ganzfeld Stimulator

The SG-2002 Ganzfeld Stimulator consists of two units: the control box and Ganzfeld. The SG-2002 is controlled by the system computer via a serial port connection.

Xenon flash tubes are used to produce the required stimulus. Any single flash or flicker can be triggered with or without a background light. The intensity of flash or flicker can be set to any of three dB levels, +25dB, 0dB or -25dB. The brightness of the background light is pre-set to any of three levels for flash/flicker or EOG. Three red LEDs, either set to bright or dim levels, are mounted at the back of the Ganzfeld for EOG testing.

2.5 CMGS-1 Color Mini-Ganzfeld Stimulator

The optional CMGS-1 Color Mini-Ganzfeld Stimulator consists of two units: the control box and hand-held mini-Ganzfeld. The CMGS-1 is controlled by the system computer via a serial port connection.

Various color LEDs are used to produce the required red, green, blue or white stimulus. Any single flash or flicker can be triggered with or without a background light. The intensity of white flash/flicker can be set to any of these dB levels: +10, +5, 0, -5, -10, -15, -20 and -25dB, while the color R/G/B flash/flicker can reach +2dB for maximum. The background light brightness is pre-set to any of three levels for any of the white, red, green and blue colors. The CMGS-1 also provides On/Off Response stimuli with W/R/G/B color. A dim red LED is mounted at the back of the mini-Ganzfeld for fixation function.

2.6 MGS-2 White-Only Mini-Ganzfeld Stimulator

The optional MGS-2 Mini-Ganzfeld consists of two units: the control box and hand-held mini-Ganzfeld. The MGS-2 is controlled by the system computer via a serial port connection.

A number of bright white LEDs are used to produce the required stimulus. Any single flash or flicker can be triggered with or without background light. The intensity of flash or flicker can be set to +5, 0, -5, -10, -15, -20 or -25 dB level. The brightness of the background light is fixed to 30cd/m² for flash and flicker stimuli, and can be turned on or off from the computer. A dim red LED is mounted at the back of the mini-Ganzfeld for fixation function.

2.7 Overall Equipment Interrelations

Figure 3.1a and **Figure 3.1b** on the last pages of this manual show how the various elements of an EPIC-4000 system are interconnected.

The functional paths are:

- Signal
- Control
- Display

Signals travel from the patient through the patient cable to the isolated patient amplifiers located in the Interface Unit. There the signals are amplified and passed on to the filters and attenuators. From the Filter / Attenuator board, the signal travels through the Analog Cable to the Analog to Digital (A/D) Converter which is an internal part of the computer. The computer collects signals for averaging, computing, display and analysis.

There are two different control paths. You control the computer using the keyboard and mouse, and the computer controls the pattern stimulator monitor, or Ganzfeld, or Mini-Ganzfeld and A/D board, from where command data are sent to the amplifiers and filters.

There are three displays in the system: the computer display, the pattern stimulator display and the printer.

3.0 Setting up the System

3.1 Inventory

The EPIC-4000 testing system consists of various electronic units: an interface unit, an isolation transformer, a pattern monitor stimulator, a Ganzfeld or/and mini-Ganzfeld stimulator and a computer with its associated peripherals. The equipment should be arranged on workstations or tables.

Make sure that the patient location is as far as possible from power mains or electromagnetic devices to minimize 60 or 50 Hz electromagnetic interference. Additionally the patient should not be seated where he or she can be touching the Interface Unit or other electrical apparatus during testing. Therefore, the Pattern Stimulator or Ganzfeld Stimulator should be placed on the workstation that does not contain the Interface Unit. The best arrangement for the EPIC-4000 system is where Interface unit and Computer Unit are placed on one workstation and the Stimulator on the other workstation as follows:

- A. Operator's Station
 - Computer
 - Operator Monitor
 - Keyboard
 - Mouse
 - Printer
 - Interface Unit
 - Isolation Transformer
- B. Patient's Station
 - Video Pattern Stimulator
 - Ganzfeld or Mini-Ganzfeld Stimulator

3.2 Precautions

3.2.1 Power Isolation The isolation transformer used in the EPIC-4000 system serves to transform primary power to a low noise, isolated voltage used by the computer and other units of the system. The most important characteristics of this transformer are low noise output and low leakage current, which reduces risk to the patient under certain conditions. Therefore, everything in the EPIC-4000 should be plugged into the outlet strip on the Isolation Transformer Unit. Failure to do so may cause the system to violate safety requirements for medical equipment.

- ♪ **Important: No laser printer or any other equipment not supplied by LKC should be connected to the EPIC-4000 system without consulting LKC's engineering department.**

3.2.2 Power Mains Interference The principal external interfering signal is electrical noise generated by power lines or by electrical equipment connected to power lines. The typical electrical outlet provides a ready source of 110/220 Volt, which is about a million times greater than the amplitude of the ERG. Examples of equipment that generate electrical interference are fluorescent lights, motors (including motorized chairs), and power transformers. Power transformers radiate primarily third harmonic (e.g., 180 Hz). These items produce powerful electromagnetic fields that can induce or couple power line interference into the recordings. The closer the patient and the equipment are to these sources, the more interference will be induced into the recording equipment. The LKC "balanced" patient amplifiers will cancel most of this interference. However, if the patient leads or amplifiers are close to the power lines or to electrical equipment, power line interference may be seen in the recordings. Therefore, care should be taken to locate the testing equipment and subject away from any major source of electrical interference.

3.2.3 High Frequency Electrical Noise Beyond the power lines or equipment such as motors and transformers, electrical noise can be produced by equipment generating noise at radio frequencies. Although one might expect such signals to be filtered out by the amplifier filters, it is possible for this type of noise to generate low frequency artifacts by nonlinearities in the recording equipment and by mixing with other signals. Therefore, care should be exercised to keep the recording equipment and subject away from strong sources of radio frequency interference.

3.2.4 Shielding If you cannot find a location which is free of interfering apparatus, it is possible to create simple shielding which usually will control the interference. The shielding material can be copper or aluminum screening material which can be placed below the patient and covered with an anti-static mat or placed around interfering apparatus. The screen and mat if used should be connected to the Interface Unit with a ground wire.

3.3 Equipment Interconnections

The equipment is interconnected as shown in Figure 3.1a for a desktop version of the EPIC-4000 system and Figure 3.1b for a laptop version system.

- ♪ **Note: Make certain that the power is off before making any connections.**

All of the equipment in your EPIC-4000 must be connected for the system to function properly.

Computer to Operator's Monitor. Your desktop version system comes with connections for two monitors. In Figure 3.1a, there are two standard 15-pin VGA connectors on the back of the computer unit. Plug the operator's monitor into the lower of the two connectors.

Computer to Pattern Stimulator. Plug the pattern monitor into the upper one of the two VGA connectors on the back of the system computer.

Computer to Printer. Plug the printer into the USB connector on computer rear panel using a standard USB cable.

Computer to Keyboard. A cable connects the keyboard to the computer. The keyboard end is permanently attached; the computer end is a plug that connects to a receptacle, or to one of the USB connectors on the back of the computer.

Computer to Mouse. A flexible cable connects the mouse to the computer. The mouse end is permanently attached; the computer end is a plug that connects to a receptacle, or to one of the USB connectors on the back of the computer.

Computer to System Interface. In a desktop version EPIC-4000, the cable that connects the computer to the interface has a 25-pin female connector to the interface rear panel, and a 25-pin male connector to the data acquisition board, PCI-DAS1200JR, which is built in the computer. For a laptop version system, the 25-pin male connector goes to an adapter cable, which attaches the data acquisition card inserted in the laptop computer.

Computer to SG-2002/CMGS-1/MGS-2 Control Unit. A serial port extension cable connects the computer to the SG-2002/CMGS-1/MGS-2 Control box. The female end goes to the 9-pin RS232 connector on the back of the computer, and the male end goes to the Interface rear panel.

SG-2002 Control Unit to Ganzfeld. A 4 Foot, fiberglass-sleeved cable connects the SG-2002 control unit to the Ganzfeld. The 16-pin metal connector of the cable goes to the back panel of the control box, and the 37-pin plastic connector goes to the Ganzfeld.

CMGS-1/MGS-2 Control Unit to Color/White Mini-Ganzfeld. The Control box end of the mini-Ganzfeld cable has a 25-pin connector, which connects to the rear panel of the box, and the other end is permanently attached to the hand-held mini-Ganzfeld head.

Power Connections. The equipment requiring connections to A.C. power are the following:

- AC/DC Adaptor for Interface
- Computer
- Computer Monitor or AC/DC Adaptor if LCD Monitor is used and DC powered
- Printer or AC/DC Adaptor for Printer
- Pattern Stimulator Monitor
- SG-2002 Control Unit
- CMGS-1/MGS-2 Control Unit if either mini-Ganzfeld stimulator is ordered

♪ **All equipment other than the Isolation Transformer Unit must be plugged into the power receptacles on the Isolation Transformer. The transformer must be the only unit connected to the wall outlet.**

We recommend that you leave all of the power switches, except the computer, turned on. This way, the on/off switch of the Isolation Transformer Unit can be used to turn the entire system, except the computer, on and off.

IMPORTANT

An isolation transformer is included to provide additional isolation from the power line ground system. The transformer will limit leakage current to inconsequential levels should there be a failure in the grounding system.

NOTE: *The Transformer is required to limit the leakage current to established safe levels if there is a failure in the grounding system. No part of the system, except the Isolation Transformer Unit, should be plugged into an A.C. primary (wall) outlet. Other subsystems should be connected to the power receptacles on the Transformer Unit.*

4.0 Theory of operation

The EPIC-4000 Visual Electrodiagnostic Testing System is designed to use a Pattern Monitor or a Ganzfeld or a Mini-Ganzfeld to elicit electrical responses from the retina and visual pathways for diagnostic purposes.

The system consists of:

- A desk top computer system which has:
 - Computer
 - Keyboard
 - Mouse
 - Computer Monitor
 - Printer
 - Data acquisition board
 - Video boards for controlling the computer display and the pattern stimulator
- or
- A laptop computer system, which has:
 - Laptop computer
 - Data acquisition PC card
 - Printer
- An interface unit containing:
 - Electrically isolated patient amplifiers
 - Filters and attenuators to control the signal characteristics
- A pattern stimulator display for providing patterned stimuli
- An isolation transformer to provide isolated AC power to Interface, Computer, Printer, Monitors and Ganzfeld/Mini-Ganzfeld Stimulator
- An amplifier calibration box for amplifier gain calibration
- A monitor calibration box for pattern monitor calibration if Multi-Focal ERG is ordered

The interconnecting wiring diagram is shown in figure 4.1a for a desktop version EPIC-400 and in Figure 4.1b for a laptop version system.

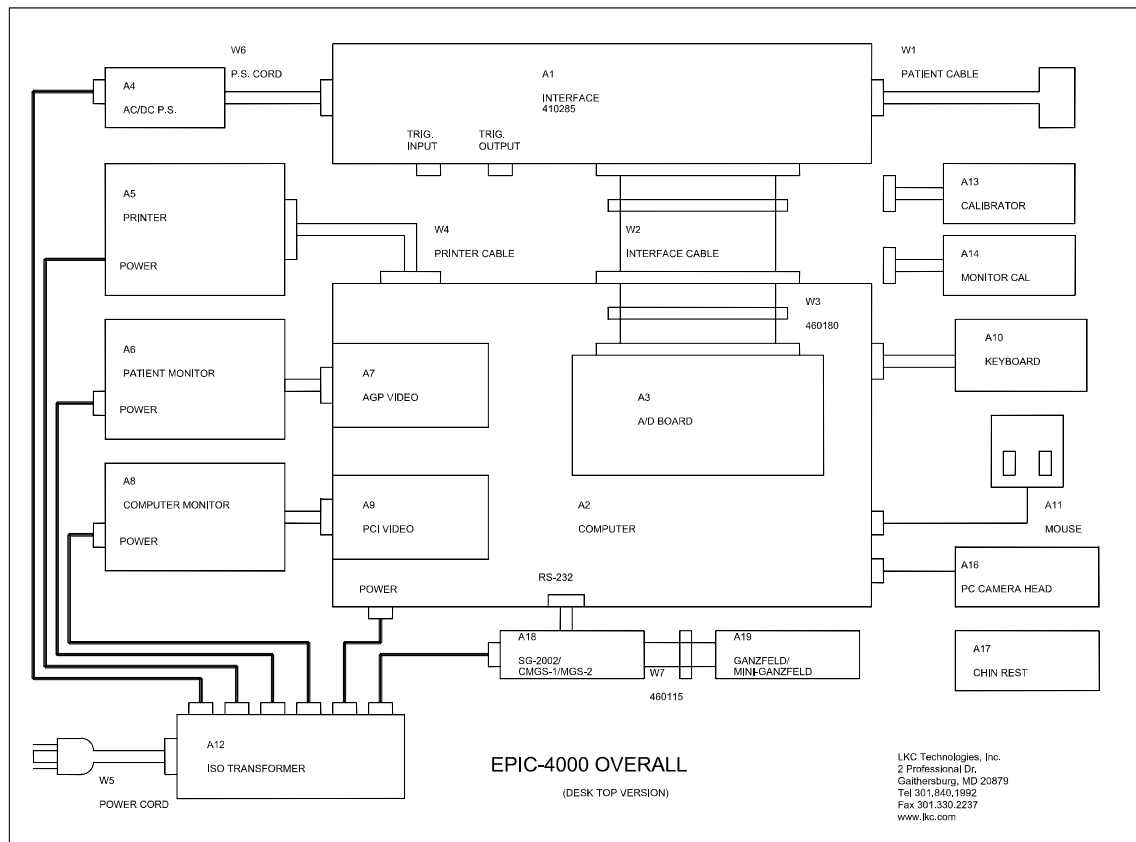


Figure 4.1a EPIC-4000 Overall (desk top version)

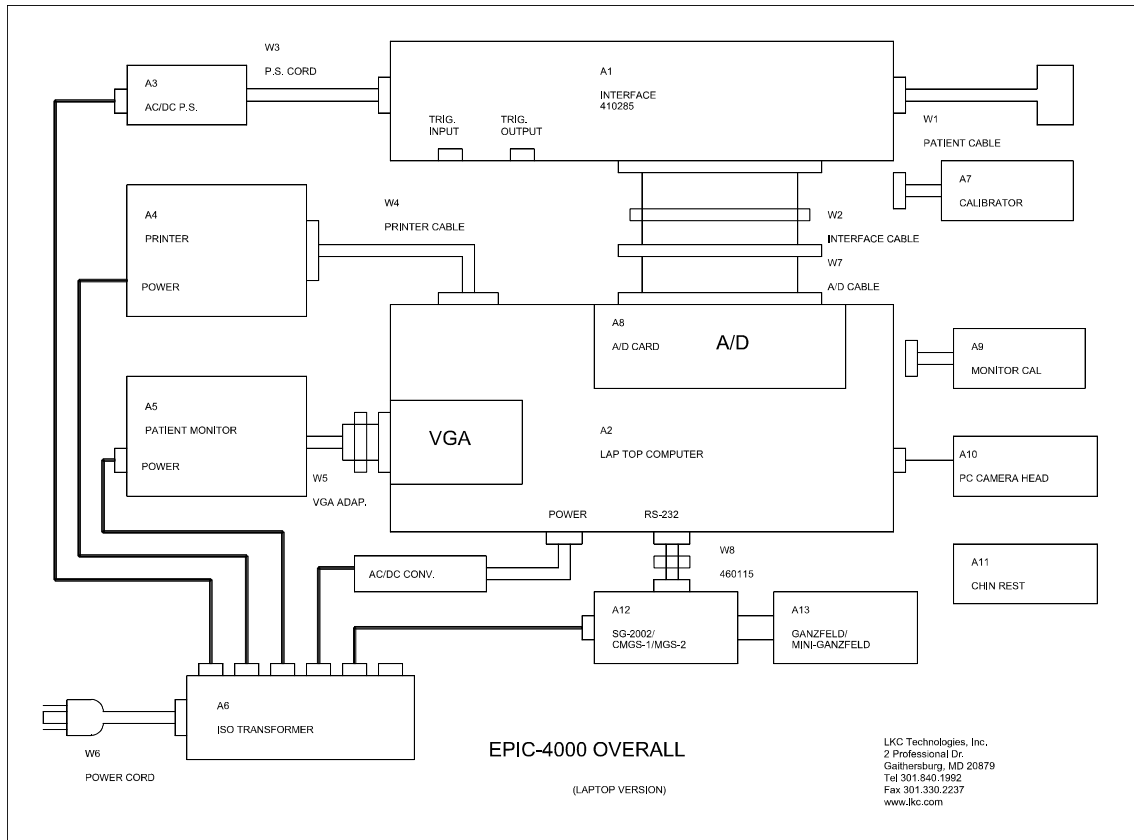


Figure 4.1b EPIC-4000 Overall (laptop version)

4.1 Interface

The Interface Unit contains all signal processing electronics of the EPIC-4000 system. The interface internal connections are shown in figure 4.2 and the signal flow block diagrams are shown in Figures 4.3, 4.4, and 4.5.

The interface is a two-channel system, which consists of one Patient Amplifier board, one Filter / Attenuator board and one Back Plane board.

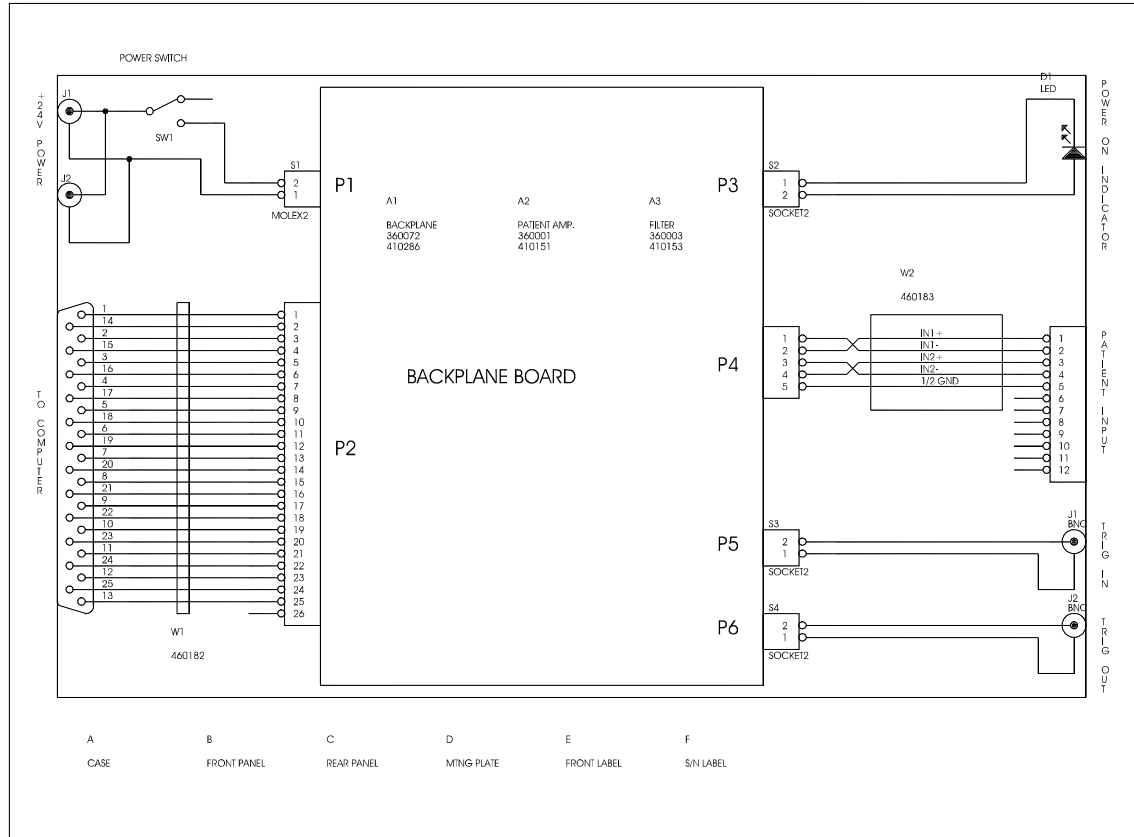


Figure 4.2 Interconnecting Wiring Diagram of the Interface Unit.

4.1.1 Patient Amplifier Module The Patient Amplifier board is the electronic module to which the patient signals are connected. The circuitry on this board provides a low-noise differential gain of 2,000 for signals connected between the positive (+) and negative (-) inputs of the patient cable. The patient amplifiers have several features to minimize the effects of interfering signals. First, the input circuitry provides a common mode rejection of over 110 dB. (That is, the gain of a signal that is common to both the + and - inputs is 0.006 while the gain of a signal between the + and - inputs is 2,000.) Further, the circuitry features an "active ground" that further increases the ability of the circuit to reject common mode signals. Another active circuit is used to remove any DC component of the input, such as that due to offsets from the electrodes.

DC offsets of up to 0.5 Volt can be successfully rejected. The input circuitry is protected against over voltage inputs (*e.g.*, from static electricity) by two different types of protective devices.

The input stages of the Patient Amplifier board are completely electrically isolated from the remainder of the EPIC-4000 system. An isolated power supply is used to supply the necessary operating voltages, and an isolation amplifier (one per channel) is used to isolate the signal path.

The Patient Amplifier board also contains an active notch filter, used to reject power mains interference. The notch filter provides 20dB attenuation at the center frequency (60 Hz or 50 Hz, depending upon the system configuration) with a half-power bandwidth of 5 Hz. This notch filter can be activated under computer control, via the data acquisition board.

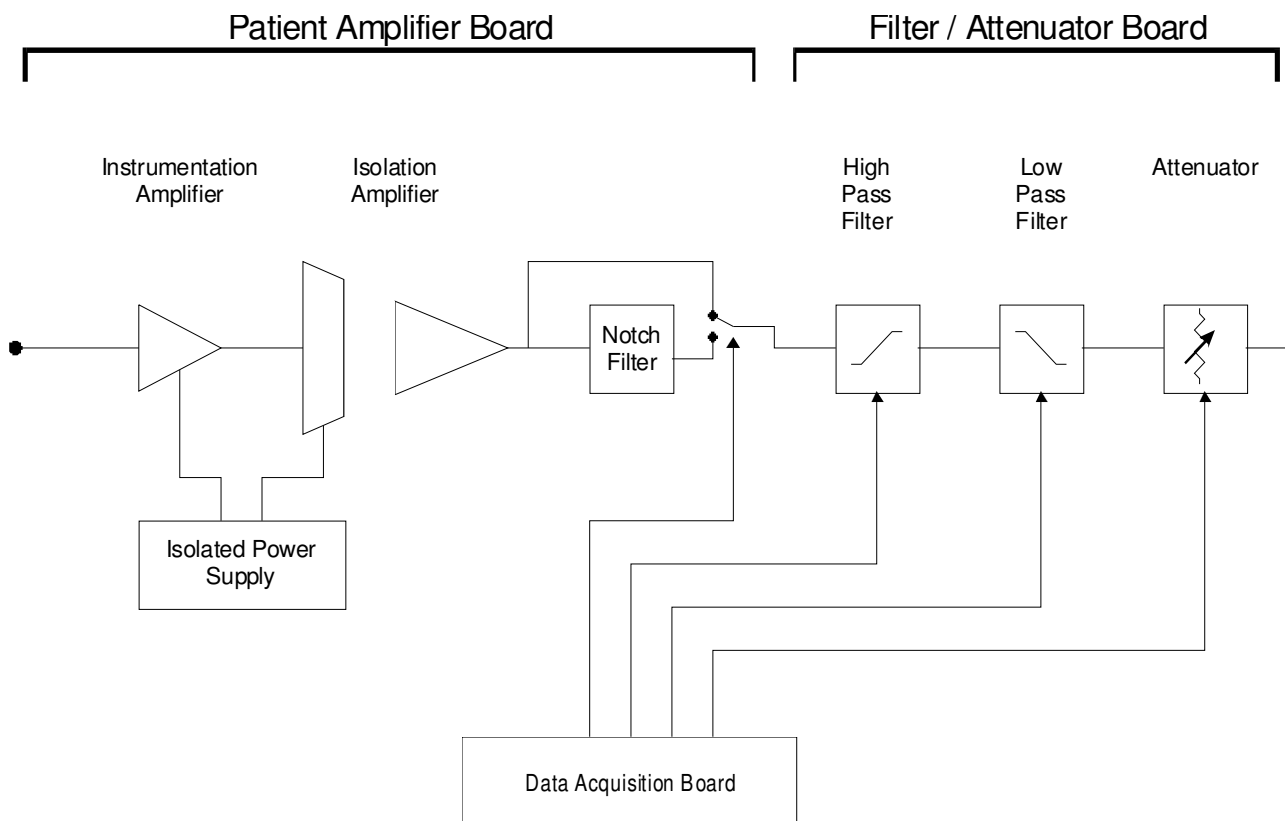
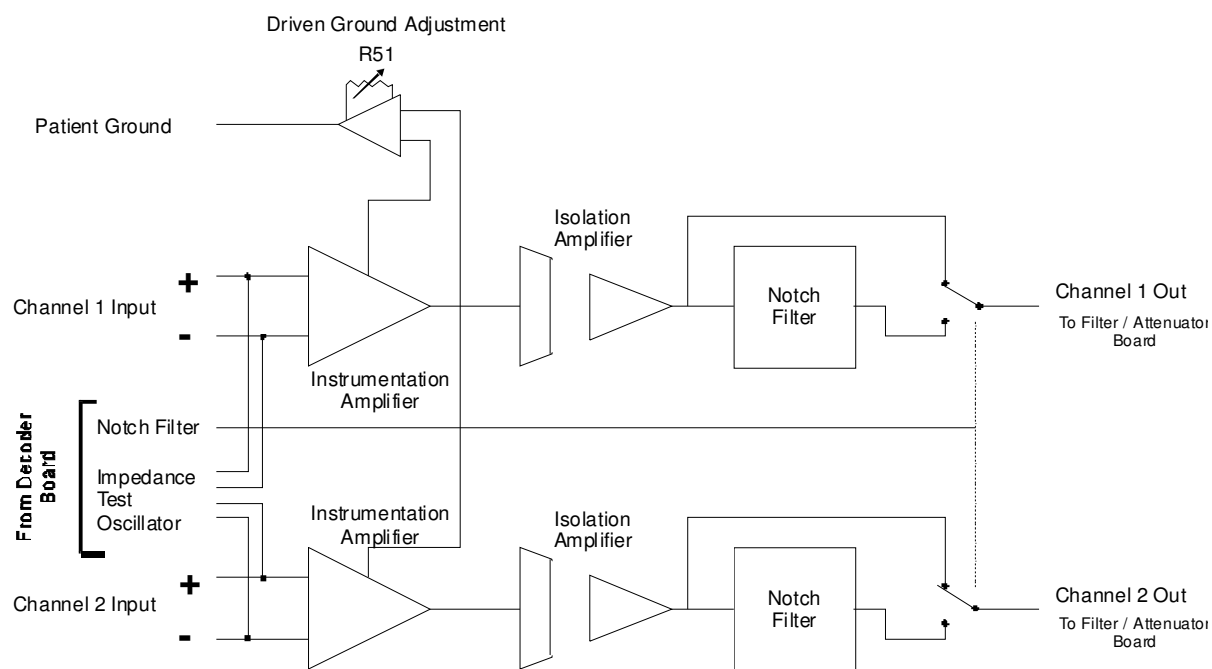


Figure 4.3 Amplifier System Block Diagram

**Figure 4.4 Patient Amplifier Block Diagram**

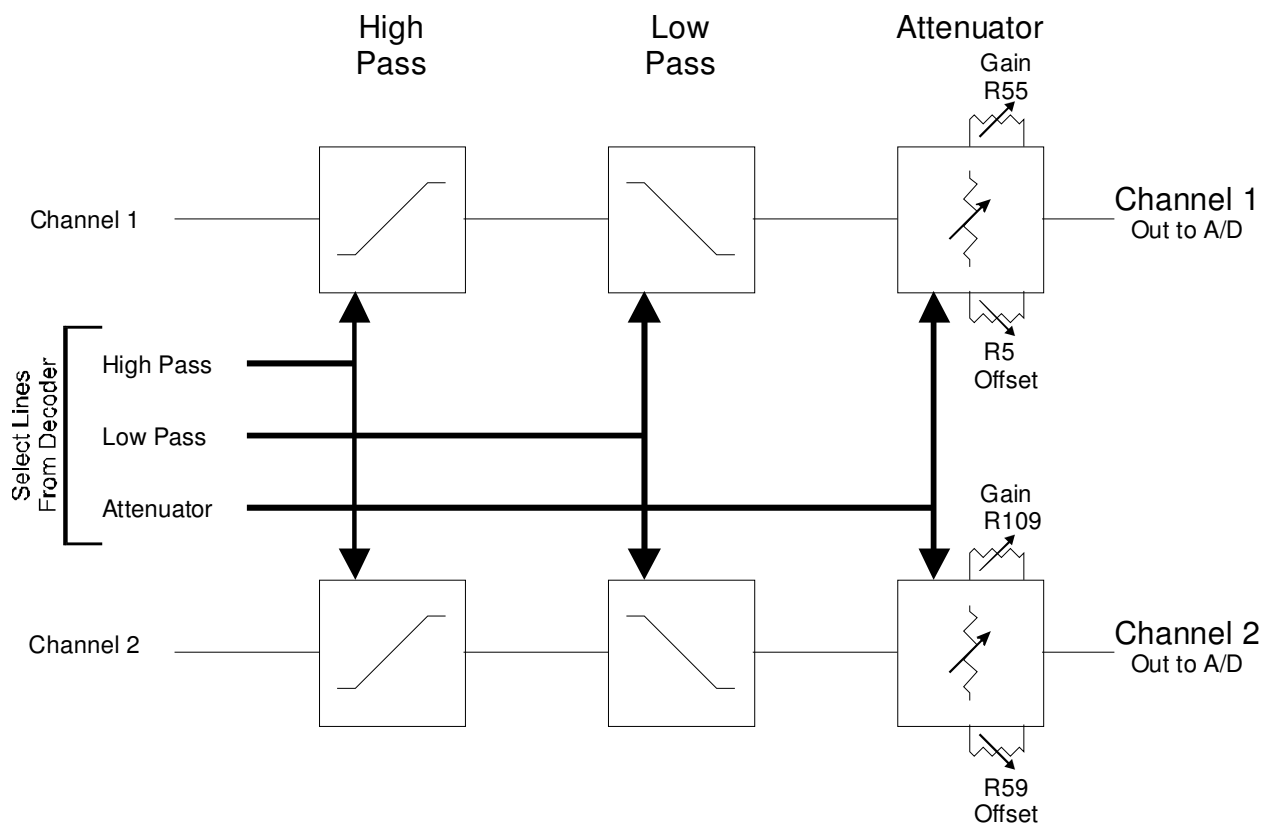


Figure 4.5 Filter / Attenuator Board Block Diagram

4.1.2 Filter and Attenuator Module The Filter and Attenuator board contains the high-pass and low-pass filter sections and the variable-gain amplifier (attenuator). The corner frequencies of the filters and the gain of the attenuator are set under computer control via the data acquisition board.

The high-pass (low cut) filter is a two-pole Butterworth filter with the following computer-selectable corner frequencies:

0.05 Hz, 0.3 Hz, 1.0 Hz, 5.0 Hz, 10 Hz, 30 Hz, 75 Hz

The low-pass (high cut) filter is also a two-pole Butterworth filter with the following computer-controlled corner frequencies:

30 Hz, 70 Hz, 100 Hz, 300 Hz, 500 Hz, 1,500 Hz, 3,000 Hz

The attenuator provides variable gain for the signal. In the DOS version EM software, we refer to the gains of the system in reciprocal units, $\mu\text{V}/\text{division}$, while in EMWin.exe, the Windows version software, the gains are expressed as Range in μV . The following table shows the relations among gains of attenuator board and two expressions:

$\mu\text{V}/\text{Div}$:	100	50	20	10	5	2	1	0.5
Range (μV):	± 2500	± 1250	± 500	± 250	± 125	± 50	± 25	± 12.5
GAIN:	1	2	5	10	20	50	100	200

The total gain of the system can be determined by multiplying the gain of the patient amplifiers (2,000) by the attenuator gain. Thus, if the Range is set to $\pm 500 \mu\text{V}$, the gain will be $2,000 \times 5 = 10,000$.

4.2 Computer

4.2.1 System Requirements The EPIC-4000 software is designed to run under the Windows XP operating system. The following is a list of the computer features:

- CPU, 2 GHz or faster
- 128 MB of RAM or better
- One 1.44 MB floppy drive plus one 20 GB or bigger hard disk drive
- One Re-Writeable CD-ROM drive
- Windows XP operating system
- One printer or USB port for printer connection
- One PS/2 or USB mouse
- One keyboard
- One flat screen CRT or LCD monitor
- One PCI slot
- One AGP video port.

Any computer systems not purchased from LKC may have subtle technical differences that can make the software incompatible. LKC Technologies will not guarantee that computers purchased from other suppliers are 100% compatible with the EPIC-4000 and its software. If the

customer purchases a computer separately, we highly recommend that the computer be sent to LKC for inspection, software installation, insertion of the data acquisition board, and a thorough testing with the system.

5.0 Calibration of the Interface Unit

The calibration of the EPIC-4000 interface consists of two procedures:

1. Calibration of gain for each channel
2. Calibration of offsets for each channel

5.1 Patient Amplifier

Each Patient Amplifier requires adjustment of the Driven Ground DC Offset. One trim pot only (R51) adjusts the offsets for both channels. Follow this procedure for each Patient Amplifier board in the system:

- 1) Place shorting jumpers across the positive (+) and negative (-) inputs for channels 1 and 2 on the patient cable.
- 2) Connect the negative (-) lead of an oscilloscope on pin 2 of the Burr-Brown 722 DC/DC Converter IC (Isolated Ground).
- 3) Connect the oscilloscope test probe on the Patient Cable Ground (**Gnd**) lead,
- 4) Make sure that no 50 or 60 Hz interference is present. Then adjust the trim pot R51 so that at the most sensitive setting of the oscilloscope (2 mV / div is sufficient), the DC offset is adjusted to 0 mV.

5.2 Filter board

There are two adjustments to be made on each Filter/Attenuator board: offset and gain.

5.2.1 Offset The offset calibration on the Filter board consists of adjustment of one trim pot for each channel. The baseline positions of the waveforms on the computer screen are set by this procedure. The procedure for this adjustment is the following:

- 1) Place shorting jumpers across the positive (+) and negative (-) inputs for channels 1 and 2 on the patient cable.
- 2) Run the EMWin software by clicking the icon EMWin on the desktop of the window.
- 3) Press the Perform Tests button on the Main Menu, and select Electro-retinogram, then Standard. Adjust Amplifier gain to $\pm 50 \mu V$.
- 4) Repeatedly press **Baseline** until the baselines are stable.
- 5) Adjust R5 and R59 trim pots for channels 1 and 2 respectively until the positions of the waveforms are approximately those shown below in Figure 5.2.1.

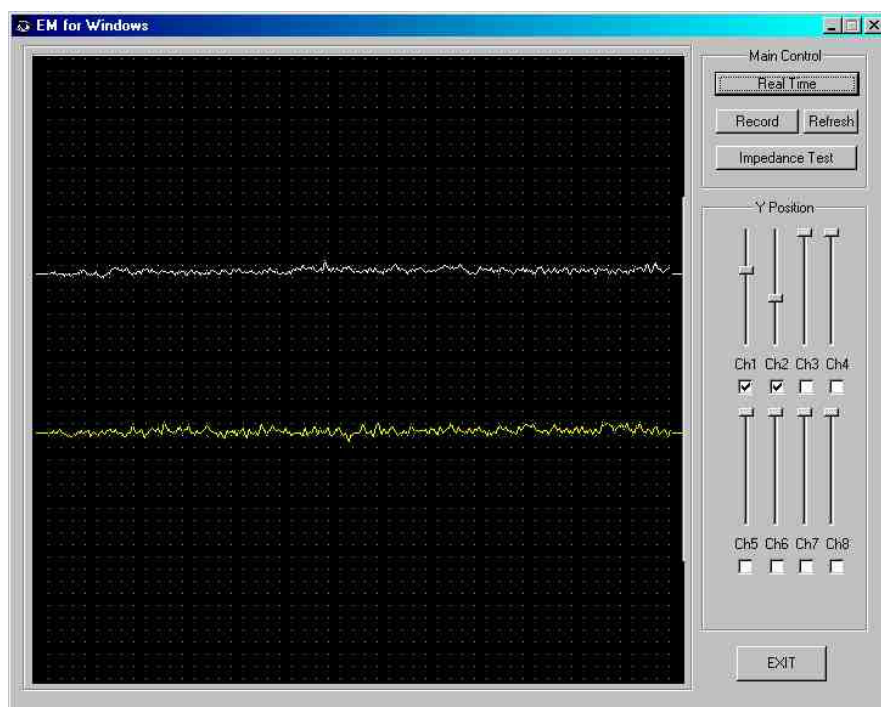


Figure 5.2.1 Adjustment of Baseline

5.2.2 Gain The gain adjustment is located on the Filter/Attenuator board. There is one adjustment per channel, which adjusts the overall system gain. The procedure for calibrating amplifier gains is as follows:

- 1) Unplug the Patient Cable and plug in the Calibrator Box.
- 2) Run the EMWin program by clicking the EMWin icon.
- 3) Press the Perform Tests button on the Main Menu, and select Electro-retinogram, then select Standard. Adjust Amplifier gain to $\pm 500 \mu\text{V}$, set the Flash level to 0 dB, and set Average to 10 times.
- 4) Turn the Calibrator Box **ON**, hold the Calibrator into the Ganzfeld with the photocell facing up and ensure the box does not touch the internal surface of the globe, and click on *Record*.
- 5) The pulses caused by the calibrator for both channels 1 and 2 displayed on the screen are as shown in **Figure 5.2.2**. Amplitude for both pulses should be $150 \mu\text{V} \pm 10 \mu\text{V}$. If not, adjust trim pots R55 and R109 on the Patient Amplifier board for channels 1 and 2 respectively until the gains are correct.

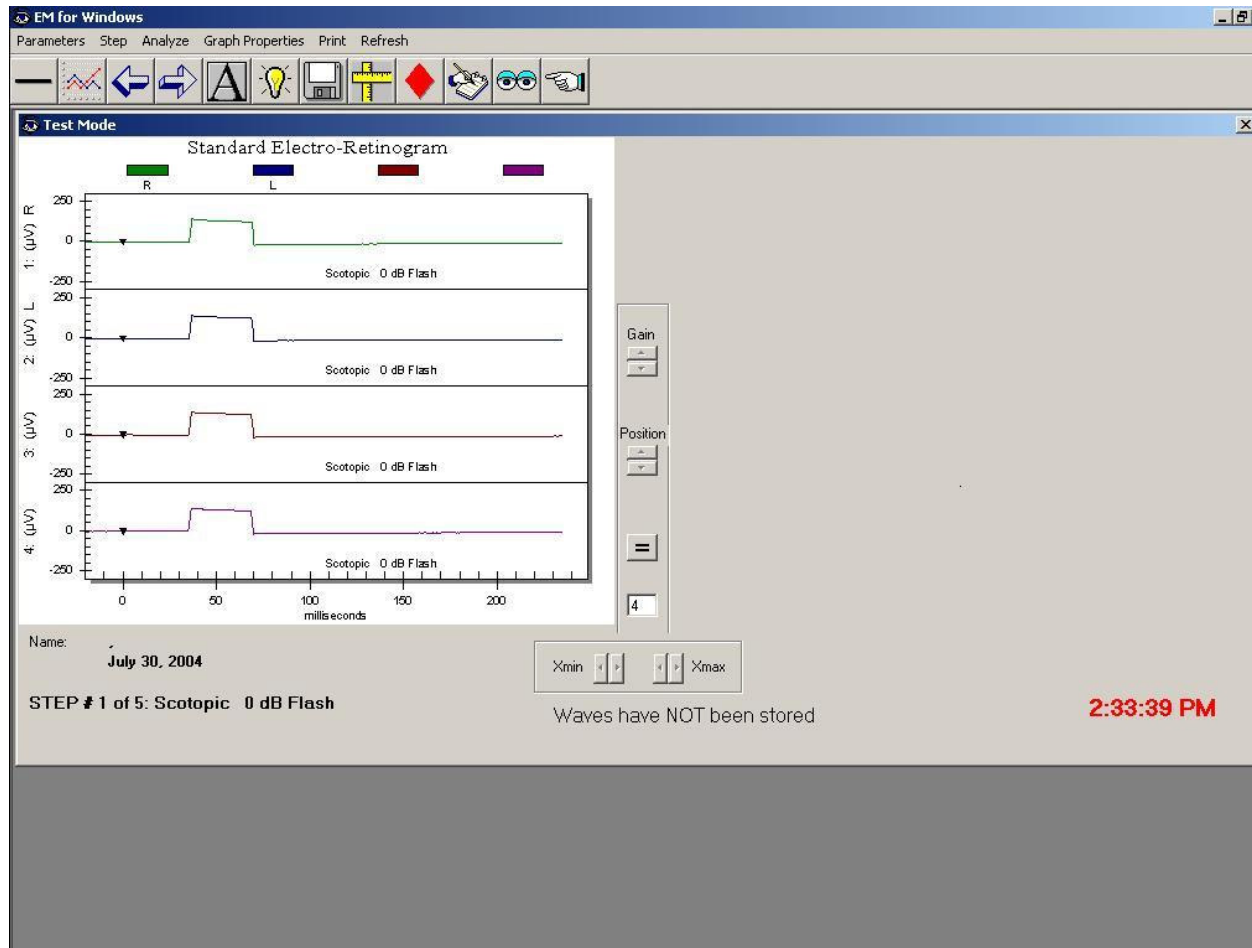


Figure 5.2.2 Gain Calibration

6.0 Calibration of the Ganzfeld

6.1 Calibration Schedule

Flash and background intensities must be calibrated at the factory. LKC recommends that users return their SG-2002 for calibration every two years.

6.2 Overview of Flash Measurements

Although the SG-2002 cannot be calibrated in the field, it is possible to test the flash intensities and background light levels if you have the proper equipment.

Flash intensities are measured in $\text{cd}\cdot\text{s}\cdot\text{m}^{-2}$ using an integrating photometer. Background light intensities are measured in $\text{cd}\cdot\text{m}^{-2}$ using a standard photometer. LKC uses EG&G DR-2550 Digital Radiometer/Photometer for calibrating systems at the factory. Other photometers are acceptable for testing if they measure light intensity in either candelas per square meter ($\text{cd}\cdot\text{m}^{-2}$) or in foot-Lamberts (fL). The photometer must also be capable of integrating its response to measure candela-seconds per square meter ($\text{cd}\cdot\text{s}\cdot\text{m}^{-2}$) or foot-Lambert-seconds (fL-s).

$$3.426 \frac{\text{cd}}{\text{m}^2} \equiv 1 \text{ ft L}$$

Flash intensities are often referred to in decibels (dB). The term dB is a relative one, as shown in the equation:

$$\text{dB} = 10 \log \left(\frac{I(x)}{I(0)} \right)$$

Where $I(0)$ is the intensity at 0 dB and $I(x)$ is the intensity at x dB. The intensity at 0 dB is between 1.5 and $3.0 \text{ cd}\cdot\text{s}\cdot\text{m}^{-2}$ for this system. So, for example, a -20 dB stimulus would be approximately $0.02 \text{ cd}\cdot\text{s}\cdot\text{m}^{-2}$.

6.3 Calibrating Background Light Intensities

The three background light intensities can be adjusted by turning a set of three potentiometers on the Ganzfeld controller board (the board on the floor of the Ganzfeld). You should measure them periodically to assure that they have not changed significantly.

Background Light Setting	Intensity (cd/m ²)	Pot Adjustment
Low	30	R12
Medium	>150	R15
High	>450	R18

6.4 Calibrating Flash Intensities

The flash intensities can also be adjusted through a set of three potentiometers on the Ganzfeld controller board. If you have an integrating photometer, you should measure them periodically to assure that they have not changed significantly. You must set your photometer to its integrating mode to measure the flash units. The flash intensity measurements must be made in a completely darkened room.

If the flash intensities are significantly lower than those shown in the table below, you should replace the flash module.

Flash Setting	Intensity (cd-s/m ²)	Pot Adjustment
Low (-25 dB)	0.006	R24
Medium (0 dB)	1.5-3.0	R22
High (+25 dB)	600-850	R20

If you have an integrating photometer, you should measure the flash intensities periodically to assure that they have not changed significantly. You must set your photometer to its integrating mode to measure the flash units. The flash intensity measurement must be made in a completely darkened room.

6.5 Replacing Background Lamps

The background lamps are quartz-halogen bulbs with a minimum life of 500 Hours. To replace the bulbs, follow this procedure:

- ◆ Turn off the power to the system at the System Interface Unit.

- ◆ Remove the top cover of the Ganzfeld by removing the 6 screws.
- ◆ The Background Light Module is on the left side when facing the front of the Ganzfeld. Remove its hold-down bracket by removing one screw.
- ◆ Remove the black Background Light Module. The bulbs are plugged into sockets inside the module.
- ◆ Replace any bulbs that are burned out.
- ◆ Carefully replace the Background Light Module, ensuring that the bulbs slide through the holes in the underlying reflector.
- ◆ Replace the hold-down bracket and replace the screw. (Note: If the hold-down bracket feels loose, you may bend it slightly to increase its pressure on the Background Light Module.)
- ◆ Replace the top cover of the Ganzfeld, and replace all 6 screws.

The quartz-halogen background lamps should maintain nearly constant brightness throughout their lifetime.

6.6 Replacing the Flash Module

Individual flash tubes are not replaceable. The three tubes are replaced as a unit. To replace the Flash Module, follow this procedure:

- ◆ Turn off the power to the system at the System Interface Unit. **Wait 10 minutes for the flash capacitors to partially discharge before proceeding.**
- ◆ Remove the top cover of the Ganzfeld by removing the 6 screws.
- ◆ The Flash Module is on the right hand side when facing the front of the Ganzfeld. Unplug the Flash Module from the Ganzfeld. Gently squeeze on the retaining clips and pull the connector off.
- ◆ Remove the hold-down bracket by removing two screws.
- ◆ Gently lift the Flash Module out.
- ◆ Carefully place the new Flash Module into position, observing the orientation of the module.
- ◆ Replace the hold-down bracket and replace the two screws. (Note: If the hold-down bracket feels loose, you may bend it slightly to increase its pressure on the Flash Module.)
- ◆ Replace the top cover of the Ganzfeld, and replace all 6 screws.
- ◆ Return the old Flash Module to LKC for recycling.

7.0 Pattern Stimulator

7.1 Overview

The pattern stimulator consists of either a flat screen CRT color VGA monitor for Pattern VER / Pattern ERG / Sweep VEP, or a high-brightness monochrome monitor if optional Multi-Focal ERG is added to the system, controlled by the AGP video card installed in the desktop computer or from the VGA output connector of the laptop computer. Commands sent by the computer to the VGA card produce changes in the display on the pattern stimulator screen. The brightness and contrast of the screen can be adjusted under computer control.

7.2 Pattern VEP/ERG Stimulator Calibration

The Pattern Stimulator Monitor is a VGA monitor that is calibrated at the LKC factory. Normally, the Pattern Stimulator Monitor will not require re-calibration. However, if the screen luminance looks too dim, follow these steps:

- ◆ From EM for Windows: Main Menu, run a Pattern VER protocol, and set the pattern alternation rate to 0.25 Hz, and 2x2 checks on the screen.
- ◆ Verify that the luminance of a white portion of the pattern stimulator screen is 30 - 50 fL using a light meter.
- ◆ If not within range, adjust the pattern monitor brightness until it is within specification.

☞ **This procedure must be performed in a dimly lit room**

7.3 Multi-Focal ERG Stimulator Calibration

The Multi-Focal Stimulator Monitor is a bright monochrome monitor that is also calibrated at LKC factory, and should be checked every month.

Pattern Stimulator Calibration Procedure

- A fast AGP video card generates the pattern on PHILIPS MGD203 as stimulus for Multi-Focal ERG tests.
- Referring to the MGD203 User Manual, check and ensure the monitor is set as the following:

3-GUNS	
KEYLOCK	OFF
ABC (Automatic Brightness Control):	OFF
REF. SETTING	1
3-BNC	

- Activate Reference Setting by pressing Bright+ and Bright- together. The front panel LED turns green.
- Adjust Contrast to full scale. Adjust Brightness to minimum. The panel LED turns red at this time.
- Referring to the MGD203 User Manual, store the Reference Setting by selecting STORE REF SET in Local Menu. The LED turns green again.
- Plug the Monitor Calibrator into the 25 pin A/D connector on the rear of the computer. Run the MonitorCal.exe program. A dimly lit rectangle will appear at the center of the screen. Place both the Monitor Calibrator and DR2550 Light Meter detector to the rectangle area and against the screen. Click the >> button in Monitor Cal window. The rectangle portion will turn to very bright.
- Measure the brightness in foot-Lamberts. If the reading is lower than 146 fL (500 cd/m²), adjust brightness, but make sure the dark portion is < 0.3 fL. Store the Reference Setting again. Record the reading as Maximum Intensity in the DHR.
- Click the Start button in the Monitor Cal window. The Auto-Calibration procedure will start. When the procedure finishes, the rectangle will display the reference brightness and the reference values will be shown in the program window.
- The Light Meter now reads the Reference Intensity in foot-Lamberts.
- Click Exit. Monitor calibration is done.

8.0 Troubleshooting Guide

This section lists the most frequently encountered problems along with typical solutions.

8.1 Boot-up

The computer does not boot up

- 1) Non-bootable diskette in drive A, or Boot files on that diskette are erased or damaged
- 2) Boot files on the C: drive are either deleted or damaged
- 3) Computer battery discharged. *CMOS memory error*

Replacement procedure: *Open the computer cover and locate the battery holder on the computer main board. Move its latch outward until the battery is ejected. Press the new battery into the holder until latched. The battery cannot be installed backwards. Setup may have to be run to restore the computer configuration.*

- 4) Hard disk ribbon cables inside the computer are loose or disconnected, or power cable to the hard disk is loose or disconnected

 **WARNING: Tighten or hook up cables with system power OFF. Cables hooked up backwards will permanently damage the hard disk.**

- 5) If none of the above seems to be the problem, then the computer may be defective.

8.2 Computer Monitor

No display on the computer monitor

- 1) Power is OFF
- 2) Video cable is loose
- 3) Power cable to monitor is loose
- 4) Video board is bad
- 5) A bad monitor

Wrong color display or reverse video display

- 1) Loose video cable
- 2) Bad video board
- 3) Bad monitor

8.3 Keyboard

No keyboard acknowledgment or keyboard error

- 1) Keyboard not connected to the computer
- 2) Bad keyboard
- 3) Key being pressed or stuck at the time of boot-up
- 4) Dirty contacts inside keyboard

8.4 Mouse

Mouse error message at the time of boot-up

- 1) Mouse not connected to the connector on the computer
- 2) Mouse bad
- 3) Computer bad

Mouse screen cursor not moving without boot-up error message as described above

- 1) No mouse software driver installed
- 2) Two different and conflicting versions of the software mouse drivers installed

8.5 RAM

RAM parity error

- 1) Bad RAM chips inside the computer.

Out of Memory Error

- 1) Computer has insufficient RAM installed
- 2) Too many programs running.

8.6 Printer

Printer Does Not Print or Prints Garbage

- 1) Printer is not on line
- 2) Printer out of paper
- 3) Disconnected printer cable at either computer or printer end

8.7 Stimulators

No flash stimulators functioning. (No Ganzfeld or Mini-Ganzfeld (optional) function)

- 1) Loose or disconnected cable from computer to stimulator control unit
- 2) Analog to digital board not tightly in place
- 3) Loose or disconnected Ganzfeld (or mini-Ganzfeld) cable at either control unit or stimulator end
- 4) Bad analog to digital (A/D) board
- 5) Bad control board in the control unit
- 6) Bad power supply in Interface Unit

8.8 Pattern Stimulator Monitor

No display on the pattern stimulator monitor

- 1) Power is OFF
- 2) Video cable is loose
- 3) Power cable to monitor is loose
- 4) Video board is bad
- 5) A bad monitor

8.9 Analog

No waveforms come up on the screen even after a long time allowed for recovery from saturation. The message "Amplifiers are Saturated" is displayed

- 1) The cable from the Interface Unit to the Data Acquisition board is disconnected or loose
- 2) Offsets on either the Patient Amplifier or the Filter / Attenuator board needs to be readjusted
- 3) Bad or absent A/D board

Waveforms are perfectly flat for both the two channels even with patient cable leads left open

- 1) Data Acquisition board is bad
- 2) The cable from the Interface Unit to the Data Acquisition board is disconnected or loose
- 3) Patient Amplifier or Filter / Attenuator board is bad

One channel is perfectly flat even with the patient cable leads left open

- 1) Bad Patient Amplifier or Filter / Attenuator board

After allowing about 1 minute for recovery from saturation, one or more of the channels is flat with a patient connected but displays power main interference when left open

- 1) Patient Amplifier DC offset needs adjustment
- 2) Filter / Attenuator board offset needs adjustment

Notch filter does not turn on but all other digital commands work

- 1) If Notch is not turned "ON" on only one channel then the Patient Amplifier board containing the Notch filter circuit is bad

8.10 Interference

Excessive power line (50 or 60 Hz) interference appearing on recordings

- 1) See Section 3.2 for setup precautions.
- 2) Be sure that good electrode contact has been achieved
 - a. Care should be taken to thoroughly clean the site of the electrode placement with skin cleaner.
 - b. All electrode cups should be filled with an adequate amount of electrode gel or cream.
 - c. A good ground connection must be made.
 - d. Check that recording connections are as recommended in the EPIC-4000 User's Manual (Software), and that unused channels are terminated with jumper cables, i.e. shorted between + and - terminals of the patient cable/cables.

In addition, electrode leads should be as short as possible and kept away from any electrical equipment or power lines. It often helps to twist the positive and negative electrode leads to cancel signals caused by magnetic induction. About one twist per inch should be

adequate. With these precautions, electrical noise due to primary power source equipment and radio frequency equipment will ordinarily be within acceptable limits.

- 3) After all steps to minimize power main noise have been taken and interference is still present in the recording signal averaging with or without, the Notch filter can be used. The Notch filter is a very narrow bandwidth filter centered at 60 (50) Hertz. It is designed to reduce 60 (50) Hertz noise by a factor of ten. There will, however, be some loss of waveform information since part of the waveform spectrum is affected.